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COSTS OF PRODUCING SHADE TREES (ACER RUBRUM) IN THE FIELD DIFFERENTIATED BY SIZE OF FIRM IN OHIO

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ABSTRACT

The objective of this study was to determine annual production costs for field-grown shade trees in Ohio differentiated by size of firm. This objective was accomplished by synthesizing two model field nurseries using the conceptual framework of economic engineering. Once the nurseries were synthesized, growing space was divided into five equal parts with each part being assigned a plant group. In the 50-acre nursery, shade trees were allocated 8 acres of growing space and in the 200-acre nursery 35 acres. One specific species of shade tree (Acer rubrum) was chosen for detailed analysis.

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In addition to research, Drs. Taylor, Smith, and Hahn have appointments in the Ohio Cooperative Extension Service.

In the space allocated, 1,869 2 inch caliper Acer rubrum could be produced annually in the 50-acre nursery and 8,177 in the 200-acre. Total costs per salable plant were $54.58 in the 50-acre nursery and $35.61 in the 200-acre. These costs were based on 1985 figures.

INTRODUCTION

Shade trees, including various species of Acer rubrum, Acer platanoides, Quercus, Fraxinus, Tilia, and Gleditsia have always been very important in the Ohio landscape. As a group they encompass a wide range of growing habits, size, foliage, flower, and fruit colors and they can be effectively used in many ways in the landscape. Shade trees are also recongnized as conservators of energy. Homes that are well shaded require less artificial cooling during Summer months.

The specific objective of this study was to determine annual production costs for shade trees grown in the field differentiated by size of firm. This information should aid Ohio nurserymen in their decisions regarding which plants to grow and in what quantities.

MATERIALS AND METHODS

In the study, two model firms were synthesized using the conceptual framework of economic engineering wherein the 'best proven practice' was included in each model. They were synthesized based on the Columbus, Ohio, area. The complete

synthesis included developing an appropriate production cycle; schematic drawings of the physical layout, including buildings and irrigation systems; lists of equipment and other items; a complete sequence by month and year of nursery operational steps beginning with propagation and ending with loading the finished product for wholesale distribution; and budgets for fixed and variable costs.

Data for this study were obtained from wholesale nurseries and nursery suppliers in Ohio during 1985. The basic goals in synthesizing the production facilities were to minimize labor expenses, flow and movement of plant material and equipment, water runoff, and initial investment, and to maximize the number of salable plants and keep future expansion possible. See Taylor et al. (1) for a detailed analysis of the physical plant, production system, and capital production budgets. In the production cycle, two year old purchased liners were prepared and planted directly into the field. Approximately 25% of the crop will be harvested and sold during the fall of the fourth field production year and another 25% dug, overwintered (healed in with wood chips), and sold during late Winter and early Spring of the fifth field production year. The remaining 50% of the crop will be harvested and sold during later Winter and Spring of the fifth field production year. After the harvest is complete, the land is left fallow and disked for weed control four times during summer months. The fields are plowed in the fall of the fifth field production year in preparation for spring planting.

A model facility was synthesized for both a 50-acre and a 200-acre field nursery. The nursery operations were assumed to produce a diverse line of nursery stock, each having its own unique production cycle. Commonly grown nursery stock was divided into five cultural groups. While not all inclusive, the groups do permit developing a range of per unit costs related to input costs and cultural factors. For analytical purposes, it was assumed that each cultural group would occupy 20% of the field growing area (i.e. 50-acre nursery = 8 acres per group, 200-acre nursery = 35 acres per group. In addition to the field growing area, the 50-acre nursery had 10 acres and the 200-acre nursery 25 acres of production facilities including overwintering houses, propagation facilities, shipping area, holding area, liner bed area, pond, supply shed, machinery storage, machine shop, office, and rest rooms. Costs developed on shade trees (Acer rubrum) therefore were based on the scale of complete nurseries, but were analyzed on the basis of percent of total space occupied. Companion studies in this publication report on fixed costs (page), slow growing evergreens (page), and deciduous shrubs (page).

For detailed analysis on shade trees, one specific plant type (Acer rubrum) was chosen, While it is recognized that other shade trees (i.e. Acer platanoides) would have somewhat different requirements, it was felt that the requirements would not vary significantly in cost from the Acer rubrum analyzed.

Costs were established for all factors of production including management and invested capital. In economic terms, costs associated with factors of production inputted by owner/operators are often referred to as 'opportunity costs' or the income these factors could have received if they were employed elsewhere. For example, owners could usually be employed as managers at other nurseries, and money invested inland, buildings, irrigation systems, and equipment could have earned interest if it had been placed in financial institutions.

Capital requirements for establishing the nurseries were first determined (1). Second, capital requirements per salable plant capacity by size of nursery were established (1). Third annual fixed costs were calculated (see page). Fourth, annual variable costs were determined for each of the two sized nurseries (Tables 1 and 2). Fifth, summaries were made for annual fixed and variable costs according to size of nursery (Table 3). This allowed cost comparisons based on size of nursery.

Most nurseries use cash rather than accrual accounting procedures. For this reason, the analyses were completed on a "cash" basis. Analysis on a cash basis does not give a true economic picture of the cost of producing a plant as it does not take into account the time value of money from the time the plant is planted until it is harvested. The analyses do, however, give a true estimate of the annual cost per salable plant based upon the study's assumptions.

Total annual production costs consist of both fixed and variable factors. Fixed costs are primarily made up of implicit costs such as depreciation on buildings and equipment, interest charges (both for borrowed and equity capital), and charges for management. Many nurserymen do not adequately consider fixed costs when computing costs of production. Fixed items are often considered as residual claimants on income. For example, management is compensated if all other factors of production have been accounted for. As noted previously, annual fixed costs are discussed in greater detail in a companion article.

Variable costs include all cost factors that vary with the quantity of plants being grown at one point in time. Variable costs are explicit, obvious, and normally paid out yearly. An example of variable costs would be the liners purchased for tree production. Two costs compose the total for purchased liners. The major cost is the purchase price. While price is somewhat dependent upon quality and quantity, it was assumed that sufficient quantity would be ordered in either sized nursery to obtain them at the lowest possible cost. The second cost was for packing and shipping the liner from producer to purchaser. This was estimated at 10% of the purchase price. Variable costs were subdivided into the following categories: propagation, materials, machinery and equipment, labor, and interest on operating capital (Tables 1 and 2). Details on specific variable costs, other than liners, are included in the companion article on slow growing evergreens (page).

RESULTS AND DISCUSSION

Annual fixed, variable, and total production costs of producing shade trees (Acer rubrum) in the field in Ohio for 1985 are summarized in Table 3. In the 50-acre nursery, total annual costs were $102,016 or $54.58 per salable 2-inch caliper tree. Fixed costs totaled $46,902 or $25.09 per plant and made up 46% of total costs. Based on percentage of total costs, land and improvements made up 7%, buildings 5%, machinery and equipment 13%, general overhead 20%, and interest on general overhead, insurance, and taxes 1%. Variable costs totaled $55,114 or $29.50 per tree and made up 54% of total costs. Based on percentage of total costs, materials made up 30%, machinery and equipment 10%, labor 11%, and interest on operating capital 3%.

In the 200-acre nursery, total annual costs were $291,165 or $35.61 per salable 2-inch caliper tree. Fixed costs totaled $88,905 or $10.87 per plant and made up 30% of total costs. Based on percentage of total costs, land and improvements made up 7%, buildings 2%, machinery and equipment 9%, general overhead 11%, and interest on general overhead, insurance, and taxes 1%. Variable costs totaled $202,260 or $24.74 per tree and made up 70% of total costs. Based on percentage of total costs, materials made up 39%, machinery and equipment 9%, labor 18%, and interest on operating capital 4%.

Total annual costs were $18.97 per tree more in the 50-acre nursery than in the 200-acre. Of this $18.97, $14.22 or 75% were made up of fixed costs. On a per item basis, the 200-acre

nursery's advantages were $1.12 on land and improvements, $1.71 on buildings, $3.94 on machinery and equipment, $7.01 on general overhead, and 44 cents on interest for general overhead, insurance, and taxes. The $4.76 difference for variable costs was $2.68 for materials, $2.27 for machinery and equipment,(-46) cents for labor, and 27 cents for interest on operating capital. It should be noted that the 46 cent differential for labor was in favor of the 50-acre nursery. In harvesting, crews would have to travel shorter distances in the smaller nursery.

In the nurseries analyzed, it cost 35% less to produce a 2-inch caliper tree (Acer rubrum) in the 200-acre nursery than in the 50-acre. While the overall reduction was 35%, it was 57% for fixed costs and only 16% for variable. Large-sized commercial field nurseries are able to make more efficient use of buildings, equipment, machinery, labor, and general overhead than is the case for small field nurseries.

One note of caution should be observed in comparing costs between the two sized nurseries. Each of the nurseries were analyzed based on the assumption that they would produce a diverse line of plants which included both shrubs and trees. This assumption might be unrealistic for the 50-acre nursery as a considerable amount of specialized equipment was required. It should also be noted that many operators of smaller nurseries might choose a different line of equipment than that budgeted. While the equipment budgeted is capable and labor

saving, smaller nurserymen might have a surplus of family labor and choose less expensive, less labor saving equipment. Also, a small nursery might well operate its office, etc. out of the home.

Individual nurserymen might well experience or at least calculate costs considerably different than those depicted here. Most cost differences would probably be reflected in fixed rather than variable costs. Most fixed costs are implicit and their full impact may not be calculated by established nurserymen. Budgets presented assumed new facilities, machinery, and equipment. Most nurserymen have owned their land for many years and have used machinery and equipment. For the established nursery, budgeted fixed costs on land improvements, buildings, machinery, and equipment presented here would reflect replacement rather than 'book' value of depreciated items. Presented fixed costs also placed a market value on management. Many nurserymen place little if any value on their own management when computing costs. Variable items, on the other hand, are explicit, experienced at least yearly, and easily accounted for. Variable costs presented here would be typical for the industry in Ohio and should be rather consistent regardless of age and size of the nursery.

SUMMARY

Total annual costs per 2-inch caliper salable shade tree (Acer rubrum) were $54.58 in the 50-acre field nursery and $35.61in the 200-acre field nursery. Fixed costs were $25.09 in the 50-acre nursery and $10.87 in the 200-acre for a differential of $14.22 per salable plant. Variable costs, on the other hand, were $29.50 in the 50-acre and $24.74 in the 200-acre for a differential of $4.76. These plant costs assumed planting purchased liners directly in the field and field growing for four years, ball and burlapped harvesting, and an average size of 2-inch caliper per salable tree.

These figures demonstrated that variable costs on a salable plant basis, at least over the size range of nurseries analyzed, had a moderate reduction of about 16% when going from a 50-acre nursery to a 200-acre. This reduction was primarily accounted for by efficiencies gained in materials, and machinery and equipment. Fixed costs, on the other hand, had a substantial reduction of about 57% as size of nursery was increased . This occurred because most of the fixed factors required to operate the 50-acre nursery such as management, buildings, and most machinery and equipment were also adequate to operate the 200-acre. As the size of nursery increased, costs for fixed items of production were spread over more salable units, thereby reducing the fixed cost per plant.

LITERATURE CITED

1. Taylor, Reed D., Harold H. Kneen, Elton M. Smith, David E. Hahn, and Stanley Uchida. 1985. Costs of Establishing and Operating Field Nurseries Differentiated by Size of Firm and Species of Plant in U.S.D.A. Plant Hardiness Zones Five and Six. Southern Coop. Ser. Bull. 315.

TABLE 1.--Variable Costs (Dollars) for Shade Trees (Acer rubrum) for a 50 Acre* Field Nursery in Ohio, 1985.

Item	Description	Unit	Cost per Unit**	Quantity	Total Variable Cost
Materials					
Burlap	54" x 54" squares + 24" basket	each	3.10	1,869.00	5,794
Twine	Nails + twine	each	0.15	1,869.00	280
Liners	6-8' 2 yr branched	each	11.09	2,076.00	23,023
Strip tags	5/8" X 7" plastic strip tag	each	0.02	1,869.00	37
Poultry wire	1" for rabbit control	roll	29.00	2.00	58
Seed	Rye Grass (Kentucky 31)	pound	0.64	348.48	223
Chemicals	Custom spread, custom blend: 45-0-0, 0-44-0, 0-0-60 (fertilizer)	ton	176.00	0.90	158
	Custom spread, (lime)	ton	20.00	1.60	32
	Urea, 45-0-0 (fertilizer)	ton	220.00	0.70	154
	Trifluralin 4 EC (Treflan) (herbivide)	gallon	33.49	0.40	13
	Simazine 80WP (Princep) (herbicide)	pound	3.75	16.00	60
	DCPA 75WP (Dacthal) (herbicide)	pound	6.37	47.04	300
	Malathion, 57EL, (Cythion) (insecticide)	gallon	18.28	14.40	263
	Benomyl, 50WP, (Benlate) (fungicide)	pound	14.17	9.60	136
	Carbaryl, 80WP (Sevin) (insecticide)	pound	6.09	24.00	146
	Other (i.e. Kelthane, Captan, Di-syston, Orthene, etc.)****				272
Subtotal					30,949
Machinery and Equipment					
	Tractor, 100 HP	hour	17.00	49.84	847
	Tractor, 34 HP	hour	4.99	22.86	114
	Flatbed truck, 24' bed	hour	14.87	125.76	1,870
	Articulated Loader/3,000lbs	hour	14.81	54.89	813
	Tree spade	hour	5.30	125.79	667
	Forks	hour	0.01	54.89	1
	Plow, 3-14"	hour	6.57	1.28	8
	Disk, 8' wide	hour	4.23	2.28	10
	Harrow, 10' wide	hour	8.45	0.19	2
	Cultimulcher, 10' wide	hour	24.70	0.34	8
	Spray rig with 10' boom	hour	2.77	2.50	7
	Transplanter, one row (tree)	hour	0.92	37.75	35
	Permanent irrigation/well & pump 100Hp	hour	7.60	15.20	116
	Inground irrigation - storage & holding	hour	5.56	12.00	67
	Above ground irrigation - storage & hold.	hour	11.05	12.00	133
	Inground irrigation - bed/field	hour	3.13	3.20	10
	Traveler gun	hour	12.06	3.20	39
	Portable PTO pump, 40 HP	hour		(no costs budgeted)	
	Airblast sprayer	hour	1.01	19.20	19
	Mower	hour	2.98	4.36	13
	Seeder	hour	1.05	2.16	2
	Sidedresser, 2 row	hour	0.63	3.84	2
	Cultivator, 2 row	hour	0.95	4.24	4
	Wagon, 4 wheel	hour	0.48	6.10	3
	Truck, 1/2 ton pickup	hour	8.42	384.42	3,237
	Flatbed truck, 24' bed	hour	14.87	125.76	1,870
Subtotal					9,897

Table 1 Cont.

Item	Description	Unit	Cost per Unit**	Quantity	Total Variable Cost
Labor					
	Labor hours	hour	6.93***	1,340.44	9,290
	Related labor hours, 20%	hour	6.93	268.00	1,858
Subtotal					11,148
Interest Charge on Operating Capital	Computed at 12% on an annual basis for 6 months	percent	6.0 (0.06)	51,994.00	3,120
Total Variable Costs					55,114
Variable Cost per Salable Plant (2" caliper)	Units available for sale in a given year	each		1,869.00	29.49

*Total Nursery - 50 acres, 40 acres of growing space, 10 acres production facilities, holding & field bed area, roads, etc. Shade Trees - 10 acres, 8 acres of growing space, 2 acres production facilities, holding & field bed area, roads, etc., 1,869, 2 inch caliper salable plants per year.

**Quantity discounts were applied to chemicals and other items.

***Average basic wage before withholding taxes and fringes $5.25, taxes and fringes add 32% or $1.68 for a total of $6.93.

****To achieve better pest and disease control, alternative chemical useage is advisable. Alternative chemical costs were estimated at 50% of the cost of Malathion, Benomyl, and Carbaryl.

TABLE 2.--Variable Costs (Dollars) for Shade Trees (Acer rubrum) for a 200 Acre* Field Nursery in Ohio, 1985.

Item	Description	Unit	Cost per Unit**	Quantity	Total Variable Cost
Materials					
Burlap	54' x 54" squares - 24" basket	each	3.10	8,177.00	25,349
Twine	Nails + twine	each	0.15	8,177.00	1,227
Liners	6-8' 2 yr branched	each	8.68	9,086.00	78,866
Strip tags	5/8" X 7" plastic strip tag	each	0.02	8,177.00	164
Poultry wire	1" poultry wire for rabbit control	roll	29.00	9.00	261
Seed	Rye grass (Kentucky 31)	pound	0.64	1,524.60	976
Chemicals	Custom spread, custom blend: 45-0-0, 0-44-0, 0-0-60 (fertilizer)	ton	176.00	3.95	695
	Custom spread, (lime)	ton	20.00	7.00	140
	Urea, 45-0-0 (fertilizer)	ton	220.00	3.08	678
	Trifluralin 4 EC (Treflan) (herbicide)	gallon	33.49	1.75	59
	Simazine 80WP (Princep) (herbicide)	pound	3.75	70.00	263
	DCPA 75WP (Dacthal) (herbicide)	pound	6.37	196.00	1,249
	Malathion, 57EL, (Cythion) (insecticide)	gallon	18.28	63.00	1,152
	Benomyl, 50 WP, (Benlate) (fungicide)	pound	14.17	42.00	595
	Carbaryl, 80WP (Sevin) (insecticide)	pound	6.09	105.00	639
	Other (i.e. Kelthane, Captan, Di-syston, Orthene, etc.)****				1,193
Subtotal					113,506
Machinery and Equipment					
	Tractor, 100 HP	hour	17.00	170.82	2,904
	Tractor, 60 HP	hour	11.68	102.20	1,194
	Tractor, 34 HP	hour	4.99	88.85	443
	Articulated Loader/2,000lbs	hour	6.67	108.75	725
	Articulated Loader/3,000lbs	hour	14.81	108.75	1,611
	Tree spade	hour	5.30	543.07	2,878
	Forks	hour	0.01	217.49	2
	Plow, 3-14"	hour	6.57	5.60	37
	Disk, 8' wide	hour	4.23	9.45	40
	Harrow, 10' wide	hour	8.45	0.84	7
	Cultimulcher, 10' wide	hour	24.70	1.47	36
	Spray rig with 10' boom	hour	2.77	10.99	30
	Transplanter, one row (tree)	hour	0.92	165.20	152
	Permanent irrigation\well & pump 100 HP	hour	7.60	26.00	198
	Inground irrigation - storage & holding	hour	5.65	12.00	68
	Above ground irrigation - storage & hold.	hour	11.05	12.00	133
	Inground irrigation - bed/field	hour	3.13	14.00	44
	Traveler gun	hour	12.06	14.00	169
	Portable PTO pump, 40 HP	hour	3.75	3.40	13
	Airblast sprayer	hour	1.01	84.00	85
	Seeder	hour	1.00	4.76	5
	Mower	hour	2.98	19.04	57
	Sidedresser, 2 row	hour	0.63	16.80	11
	Cultivator, 2 row	hour	0.95	18.48	18
	Wagon, 4 wheel	hour	0.48	26.20	13
	Truck, 1/2 ton pickup	hour	8.42	685.20	5,769
	Flatbed truck, 24' bed	hour	14.87	545.07	8,105
Subtotal					24,747

Table 2 Cont.

Item	Description	Unit	Cost per Unit**	Quantity	Total Variable Cost
Labor					
	Labor hours	hour	6.93 ***	6,320.04	43,789
	Related labor hours, 20%	hour	6.93	1,264.00	8,760
Subtotal					52,558
Interest Charge on Operating Capital	Computed at 12% on an annual basis for 6 months	percent	6.0 (0.06)	190,811.00	11,449
Total Variable Costs					202,260
Variable Cost per Salable Plant (2" caliper)	Units available for sale in a given year	each		8,177.00	24.74

*Total Nursery - 200 acres, 175 acres of growing space, 25 acres production facilities, holding & field bed area, roads, etc. Shade Trees - 40 acres, 35 acres of growing space, 5 acres production facilities, holding & field bed area, roads, etc., 8,177, 2 inch caliper salable plants per year.

**Quantity discounts were applied to chemicals and other items.

***Average basic wage before withholding taxes and fringes $5.25, taxes and fringes add 32% or $1.68 for a total of $6.93.

****To achieve better pest and disease control, alternative chemical useage is advisable. Alternative chemical costs were estimated at 50% of the cost of Malathion, Benomyl, and Carbaryl.

Table 3.--Summary of Annual Fixed, Variable, and Total Costs (Dollars) of Producing Shade Trees (Acer rubrum) in the Field in Ohio, 1985.

Item	50 Acre Field Nursery*			200 Acre Field Nursery**		
	Cost	Cost per Salable Plant	Percent of Total Cost	Cost	Cost per Salable Plant	Percent of Total Cost
Fixed Cost Items						
Land and Improvements	7,061	3.78	7	21,716	2.66	7
Buildings	4,740	2.54	5	6,811	.83	2
Machinery and Equipment	13,173	7.05	13	25,495	3.11	9
General Overhead	20,592	11.01	20	32,685	4.00	11
Interest on General Overhead, Insurance, and Taxes	1,336	.71	1	2,198	.27	1
Subtotal	46,902	25.09	46	88,905	10.87	30
Variable Cost Items						
Propagation	***	***	***	***	***	***
Materials	30,949	16.56	30	113,506	13.88	39
Machinery and Equipment	9,897	5.30	10	24,747	3.03	9
Labor	11,148	5.97	11	52,558	6.43	18
Interest on Operating Capital	3,120	1.67	3	11,449	1.40	4
Subtotal	55,114	29.50	54	202,260	24.74	70
Total Annual Costs	102,016	54.58	100	291,165	35.61	100

*Total Nursery - 50 acres, 40 acres of growing space, 10 acres production facilities, holding & field bed area, roads, etc.
Shade Trees - 10 acres, 8 acres of growing space, 2 acres production facilities, holding & field bed area, roads, etc.
**Total Nursery - 200 acres, 175 acres of growing space, 25 acres production facilities, holding & field bed area, roads, etc.
Shade Trees - 40 acres, 35 acres of growing space, 5 acres production facilities, holding & field bed area, roads, etc.
***Tree liners were purchased rather than propagated. Liner costs are included under materials.